Factors influencing the adoption of soil conservation technologies in the Derived savannah of Nigeria

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Abstract

This study aims at investigating the factors that influence adoption of different soil conservation technologies available to farmers in the southern guinea savannah region of Nigeria. The study area is Ogbomoso area in the derived savannah of Nigeria, consisting of five Local Government Areas (LGAs). The stratified random sampling technique was used to obtain primary data for the study using structured questionnaire. Descriptive statistics was used to analyze the socio-economic features of the farmers while the probit model was used to capture the factors influencing the adoption of soil conservation technologies among the food crop farmers. Making of ridges, which is an indigenous technology, was the most adopted soil conservation technology. The result of the probit model shows that thirteen variables are statistically significant at various levels. These are Farmers' age, Number of foodcrops grown, Farm income Extension visits per year, Cooperative membership, Labour availability, Farming scale and Risk aversion. Others are Off-farm-income, Credit availability, Educational level, Major occupation and Farming experience. All the significant variables are positively related to the probability of adoption except Risk aversion and Off-farm income, which are inversely related to the probability of adoption of soil conservation technologies. Based on the findings of this study, it is recommended that policy makers should incorporate farmers' literacy programme into extension services rendered by the Oyo State Agricultural Development Programme (OYSADEP). This will afford the farmers the opportunity to understand non-traditional technologies and increase their probability of adoption of these technologies.

Key words: soil conservation technologies, adoption, derived savannah, Nigeria

Introduction

Nigeria is predominantly an agricultural country, which depends largely on small-scale farmers using traditional farming methods. This has resulted into decrease in per caput food supply, increased domestic food demand and supply gap and has consequently led to increase in food import bill over the years (FAO, 2003). There is an urgent need to increase food supply to reduce the gap in food demand and supply. Agricultural production should therefore be boosted by increasing the area under cultivation and by adopting more intensive methods of farming (Perreira, 1993). A major problem facing tropical agriculture is the inherent low fertility status of most of the soils because of the predominant low-activity clay minerals (Feller,1993; Obatolu and Agboola,1993). Also, soil degradation resulting from desertification, deforestation, soil erosion, traditional farming systems, continuous cropping,, overgrazing, heavy mechanization and other agricultural and non-agricultural activities greatly impair the sustenance potentials that are derivable from the fragile Nigerian soils which by nature are shallow and low in fertility (Lal,1987; Kang,1993). Thus, appropriate soil management practices for specific crops, soils and agro ecological zones aimed at sustaining high crop yields and preventing soil degradation are one of the key factors in the development of sustainable agricultural systems (Opara-Nadi, 1993). This study, therefore, aims at identifying the soil conservation technologies practised by the farmers and investigating the factors that influence adoption of non-traditional soil conservation technologies available to farmers in the study area.

Literature review

Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable agriculture has been defined variously by different authors (Idachaba, 1987; Young, 1989; Keaney, 1989; Okigbo, 1991; Spencer and Swift, 1992). However, FAO (1989) defined sustainable agriculture as one which involves the successful management of resources for agriculture to satisfy human needs, while maintaining or enhancing the quality of the environment and conserving natural resources.

A common philosophy among sustainable agriculture practitioners is that a "healthy" soil is a key component of sustainability; that is, a healthy soil will produce healthy crop plants that have optimum vigor and are less susceptible to pests. Sustainable farmers maximize reliance on natural, renewable, and on-farm inputs. Equally important are the environmental, social, and economic impacts of a particular strategy. Converting to sustainable practices does not mean simple input substitution but frequently, it implies the substitution of enhanced management and scientific knowledge for conventional inputs, especially chemical inputs that harm the environment on farms and in rural communities. The goal is to develop efficient, biological systems that do not need high levels of material inputs. Sustainable approaches are those that are the least toxic and least energy intensive, and yet maintain productivity and profitability. Preventive strategies and other alternatives should be employed before using chemical inputs from any source (Feenstra,1997).

Feenstra (1997) further stated that by helping farmers to adopt practices that reduce chemical use and conserve scarce resources, sustainable agriculture research and education can play a key role in building public support for agricultural land preservation. In combination with other strategies, sustainable agriculture practices and policies can help foster community institutions that meet employment, educational, health and cultural needs.

Human existence depends largely upon the thin layer of soil from which food and cash crops are produced. If used for right purposes and managed well, soil can continue to meet human needs indefinitely. If otherwise, soils can quickly degrade, decline in fertility and lose its potential to meet human needs. In sustainable systems, the soil is viewed as a fragile and living medium that must be protected and nurtured to ensure its long-term productivity and stability.

The aim of soil conservation is to obtain the maximum sustained level of production from a given area of land while maintaining soil loss below a threshold level (Morgan, 1995). Any soil conservation strategy must be technically sound and socially and economically acceptable to the farmer. Increasingly, it is recognized that strategies for soil conservation must rely on improving traditional systems instead of imposing entirely new techniques from outside (Roose, 1992). Also, soil conservation strategies must improve yield, decrease the input of labour or fertilizer and must lead towards improved land husbandry (Hudson, 1995). Methods to protect and enhance the productivity of the soil include using cover crops, compost and/or manures, reducing tillage, and maintaining soil cover with plants and/or mulches.

Raintree (1983) stated that adoptability of a technology is greatly enhanced when the proposed technology holds a potential to solve the "perceived problem" in a particular location. Adoption of soil conservation technologies is a function of the characteristics of the technology proposed, perception of need, the availability and distribution of factors of production, perception of risk, infrastructural facilities, family size, availability of land, extension visits and socioeconomic characteristics of the farmers like age, farm size, level of income, level of education and sex (Roumasset, 1976; Anderson et al, 1977; Adekunle, 1993 and Wiersum, 1994).

Pender and Kerri (1998) found out that soil conservation investment was significantly lower on leased land in two of the study villages in semi-arid India and lower on plots that are subject to sales restriction in the third village. The model of imperfect labour market showed that households with more adult males, more farm servants, less land, more debt and off-farm income, farmers' education and caste, characteristics of plots (size, slope, irrigation status and quality ranking) and the presence of existing land investment influence the adoption of soil conservation investment.

Aromolaran (1998), in a study to analyse the soil conservation options open to farmers in Ogun state, Nigeria, found out that the most important socio- economic factors influencing the level of investment in soil conservation include land ownership status, farming experience and frequency of extension contact. It was also observed that there was competition between investment in fertilizer as a short-term soil fertility technique and other long-term and sustainable soil conservation practices.

Objectives of the study

The primary objectives of the study is to investigate the factors that influence adoption of different soil conservation technologies available to farmers in the southern guinea savannah region of Nigeria. The specific objectives are to:

(i) identify the soil conservation technologies practised by the farmers;
(ii) determine farmers' level of adoption of soil conservation technologies;
(iii) investigate the determinants of adoption of non-traditional soil conservation technologies available to farmers in the study area; and
(iv) make policy recommendations based on the findings of this study.

Research methodology

The study area is Ogbomoso land in Oyo state of Nigeria. It comprises five local government areas (LGAs) namely Ogbomoso south, Ogbomoso north, Ogo-Oluwa, Surulere and Oriire. The area falls within the derived savannah ecological zone. Ogbomoso land was selected because majority of the residents are predominantly food crop farmers who have cultivated their lands over several decades.

The stratified random sampling technique was used to obtain data for the study through the use of structured questionnaires. The first step is the choice of stratification of the five LGAs in Ogbomoso land. The list of all the villages in these areas was obtained from the Ogbomoso zonal office of Oyo State Agricultural Development Programme (OYSADEP). From this list, a random selection of three villages from each of the five Local Government Areas was done. The final step involved the random sampling of farmers in each of the villages. Eleven questionnaires were administered in each of the fifteen selected villages. A total of one-hundred and fifty-one farmers gave consistent responses.

Descriptive statistics was used to analyse the socio-economic characteristics of the farmers while the probit model was used to capture the factors influencing the adoption of improved soil conservation technologies among the food crop farmers.

The Probit model

The probit model was used to analyze the determinants of the adoption of non-traditional soil conservation technologies. The choice of explanatory variables in the model was based on literature review. These include farmers' socio-economic characteristics, farm characteristics, farm and non-farm income. Others are the use of infrastructural facilities, credit, farmers' attitude towards risk and the simplicity or otherwise of the soil conservation technology.

The relationship between the probability of adoption variable,Pi, and its determinants, q_i, is given as:

$$P_i = ß q_i + \mu_i$$

where $P_i = 1$ for $X_i \geq Z$

$i = 1, 2 \ldots, n.$

q_i is a vector of explanatory variables and ß is the vector of parameters. The probit model computes the maximum likelihood estimator of ß given the non-linear probability distribution of the random error μ_i.

The dependent variable P_i is a dichotomous variable, which is one when a farmer adopts any of the non-traditional soil conservation technologies (agroforestry, vertiver grass, chisel plough, minimum tillage, strip cropping and compost) and zero if otherwise.

The explanatory variables q_i are:

X_1= Farmers' age in years

X_2 = Dummy variable for Educational status (educated =1, not educated=0)

X_3 = Dummy variable for Major occupation (farming =1, others=0)

X_4 = Farming experience in years
X_5 = Household size
X_6 = Total farm size (ha)
X_7 = Number of food crops grown
X_8 = Off-farm income in ₦
X_9 = Farm income in ₦
X_{10}= Extension visits per year
X_{11}= Dummy variable for Cooperative membership (member =1, non-member =0)
X_{12}= Distance of input source (km)
X_{13}= Production system (Crops only=1, Crops/livestock=0)
X_{14}= Labour availability in standard days
X_{15}= Dummy variable for Access to Irrigation facilities (Yes=1, No=0)
X_{16}= Dummy variable for Access to Storage facilities (Yes=1, No=0)
X_{17}= Dummy variable for Credit availability (Yes=1, No=0)
X_{18}= Dummy variable for Market surplus (Yes=1, No=0)
X_{19}=Dummy variable for Soil erosion characteristics (mild=1, severe=0)
X_{20}= Dummy variable for Land ownership status (land owner=1, others=0)
X_{21}= Farming scale (commercial=1,if otherwise=0)
X_{22}= Dummy variable for Risk aversion (Yes=1, No=0)
X_{23}= Dummy variable for Perception of complexity of technology (complex=1, not-complex=0)

The explanatory variables included in the analysis are based upon the theory discussed above and the literature on adoption.

Results and Discussion

Table 1: Farmers' level of awareness of soil conservation technologies

Soil Conservation Technologies	Aware Frequency (percentage)	Not aware Frequency (percentage)
Traditional technologies		
Making of ridges	151(100.0)	0(0.0)
Fertilizer application	146(96.7)	5(3.3)
Crop rotation	134(88.7)	17(11.3)
Mulching	130(86.1)	21(13.9)
Cereal/Legume Inter-cropping	120(79.5)	30(20.5)
Cover crops	119(78.8)	32(21.2)
Green manure	85(56.3)	66(43.7)
Contour bunds	72(47.7)	79(52.3)
Tied ridges	65(43.0)	86(57.0)
Non-traditional technologies		
Compost	73(48.3)	78(51.7)
Strip cropping	57(37.7)	94(62.3)
Minimum tillage system	54(35.8)	97(64.2)
Agroforestry	52(34.4)	99(65.6)
Vertiver	50(33.1)	101(66.9)
Chisel plough	21(13.9)	130(86.1)

Source: Field Survey, 2003.

Table 1 above shows the level of farmers' awareness of soil conservation technologies. Among the traditional conservation technologies, the level of awareness among farmers is high for making of ridges, fertilizer application, crop rotation, mulching, cereal legume intercropping and cover crops. Not less than 70 percent of the respondents are aware of the traditional technologies with the exception of green manure, contour bunds and tied ridges, which represent

56.3 percent, 47.7 percent and 43.0 percent of the non-traditional soil conservation technology among the respondents is highest for compost (48.3 percent) and least for chisel plough (13.9 percent). The result shows that the respondents are more aware of traditional technologies than non-traditional technologies. A plausible reason for this respondents respectively. The level of awareness of is that traditional technologies are indigenous to the farmers and are age-long technologies, which they have practised and proven over the years. However, this indicates a low impact of agricultural extension services in the study area.

Table 2: Farmers' adoption of soil conservation technologies

Technologies	Adopters	Non-Adopters
	Frequency(percentage)	Frequency(percentage)
Traditional technologies		
Making of ridges	135(89.4)	16(10.6)
Fertilizer application	133(88.1)	18(11.9)
Mulching	119(78.8)	32(21.2)
Crop rotation	115(76.2)	36(23.8)
Cereal/Legume Inter-cropping	113(74.8)	38(25.2)
Cover crops	96(63.6)	55(36.4)
Green manure	49(32.4)	102(67.6)
Tied ridges	48(31.8)	103(68.2)
Contour bunds	45(29.8)	106(70.2)
Non-traditional technologies		
Strip cropping	44(29.1)	107(70.9)
Compost	38(25.2)	113(74.8)
Agroforestry	33(22.5)	117(77.5)
Minimum tillage	32(21.2)	119(78.8)
Chisel plough	16(10.6)	135(89.4)
Vertiver grass	12(7.9)	139(92.1)

Source: Field Survey, 2003.

Table 2 shows that farmers exhibit a high level of adoption (over 60 percent) to making of ridges, fertilizer application, mulching, crop rotation, legume intercropping and cover crops. The probable reasons for the high level of adoption of these technologies are high level of awareness, simplicity and relative cheapness of these traditional technologies. However, less than 35 percent of the respondents adopt green manure, tied ridges and contour bunds. The low level of adoption of these technologies reflects the low level of awareness and probably the labour intensive nature of these technologies.

Strip cropping is the most adopted non-traditional technology. This could be because it is the least capital intensive and simple technology of the non-traditional soil conservation technologies. The low level of adoption of the non-traditional technologies is a reflection of the low level of awareness of these technologies. The result also shows that traditional conservation technologies are more adopted than non-traditional conservation technologies. This is consistent with the result in Table 1. This is because the level of awareness of a technology is directly related to its level of adoption. Other probable reasons are that the non-traditional soil conservation technologies are more capital and labour intensive; require a higher level of scientific knowledge and the effect on soil nutrient improvement is not immediate. This reflects the fact that farmers prefer traditional technologies, which proffer quick solution to the problems of soil erosion and nutrient depletion, to non-traditional conservation technologies, which are more sustainable.

Factors influencing the adoption of non-traditional soil conservation technologies were investigated using the probit model. The result is given in Table 3 below.

Table 3: Result of the probit model

Independent Variables	Regression Coefficient	Standard Error	T-value
Farmers' age (X_1)	0.01738	0.00189	9.21875***
Educational level (X_2)	0.10580	0.00570	1.85427*
Major occupation (X_3)	0.00938	0.00561	1.67118*
Farming experience (X_4)	0.00316	0.00167	1.88950*
Household size (X_5)	0.00146	0.00243	0.60228
Total farm size (X_6)	0.00208	0.00153	1.35894
Number of foodcrops grown (X_7)	0.03115	0.00956	3.25821***
Off-farm income(X_8)	-0.04048	0.01692	-2..39187**
Farm income(X_9)	0.00470	0.00110	4.27790***
Extension visits per year (X_{10})	0.03994	0.00734	5.44291***
Cooperative membership (X_{11})	0.42580	0.15280	2.78664***
Distance of input source (X_{12})	0.00383	0.01186	0.32285
Production system (X_{13})	-0.09005	0.05977	-1.50678
Labour availability (X_{14})	0.05737	0.01855	3.09288***
Irrigation facility (X_{15})	0.01517	0.07122	0.21294
Storage facility (X_{16})	-0.02308	0.00226	-1.02378
Credit availability (X_{17})	0.01212	0.00576	2.10383**
Market surplus (X_{18})	-0.01791	0.03471	-0.51587
Soil erosion characteristics (X_{19})	0.01119	0.06019	0.18599
Land Ownership status (X_{20})	0.01894	0.01347	1.40670
Farming scale (X_{21})	0.19326	0.02512	7.69429***
Risk aversion (X_{22})	-1.03034	0.38024	2.70971***
Complexity (X_{23})	-0.6203	0.08468	-0.73253

Source: Field Survey, 2003.
Chi-square value = 6940.53***
N= 151
* Significant at 10% ** Significant at 5% *** Significant at 1%

The chi-square value was used to determine the goodness of fit of the model. The value is statistically significant at one percent level. The result also shows that thirteen variables are statistically significant at various levels. Seven variables are statistically significant at one percent level. These are Farmers' age(X_1), Number of foodcrops grown(X_7), Farm income(X_9), Extension visits per year(X_{10}), Cooperative membership(X_{11}), Labour availability(X_{14}), Farming scale(X_{21}) and Risk aversion(X_{22}).The two variables that are statistically significant at five percent level are Off-farm income(X_8) and Credit availability(X_{17}). In addition, the three variables that are significant at ten percent level are Educational level(X_2), Major occupation(X_3) and Farming experience(X_4). All the significant variables are positively related to the probability of adoption except Risk aversion(X_{22}) and Off-farm income(X_8) that are inversely related to the probability of adoption of soil conservation technologies.

It can be deduced that the higher the farmers advance in age, educational level and farming experience, the higher their probability of adoption of any of the non-traditional soil conservation technologies. In addition, the more the farmers focus on foodcrop farming as their major occupation and as the number of foodcrops grown by farmers increase, the more likely they are to adopt any of the non-traditional soil conservation technologies. The positive relationship between cooperative society membership and probability of adoption indicates that farmers who are members of cooperative societies have a high probability to adopt at least one of the non-traditional soil conservation technologies. This is because the high level of interaction among members of the same group is a means of disseminating innovation to the members. Cooperative societies are reliable sources of credit to members, which could encourage farmers to adopt improved technologies. Increase in farm size and units of farm labour will increase the probability that the farmer would adopt any of these non-traditional technologies. Thus, commercial farmers would be more willing to adopt these technologies than subsistence farmers would.

As farmers generate more income from off-farm activities, the less the probability of adoption of non-traditional soil conservation technologies by them. However, as the income generated from farm activities increase, the higher their probability of adopting these technologies. This shows that farmers will be willing to invest in any enterprise that is yielding high returns. In conformity with apriori expectation, risk averse farmers have low level of probability of adoption of non-traditional soil conservation technologies.

Conclusion and recommendations

The result shows that majority of the farmers have adopted at least one soil conservation technology, either traditional or non-traditional. Traditional soil conservation technologies are preferred to non-traditional technologies, which are more sustainable. This could be explained by the high level of risk aversion of farmers, low level of extension contact, low level of farm income, high labour intensity of some of these technologies, low level of cooperative membership and high level of illiteracy.

The agricultural extension services rendered by the Oyo State Agricultural Development Programme (OYSADEP), which is almost moribund, should be resuscitated and well facilitated in terms of human, natural and financial capitals. In addition, policy makers should incorporate farmers' literacy programme into extension services. This will afford the farmers the opportunity to understand non-traditional technologies and increase their probability of adoption of them.

To increase awareness of the non-traditional technologies, the information sources of farmers must be intensified. Hence, the use of radio programmes, posters, bulletins, newspaper column and audio-visual aids like documentary films in local languages should be intensified for efficient dissemination of information to farmers. Agricultural cooperative societies should be encouraged in the rural areas by the government through adequate and prompt supply of input and credit facilities to the farmers via these societies. Membership of these cooperative societies is expected to improve agricultural information dissemination and encourage economies of scale through collective purchase of farm inputs. It would also minimize activities of intermediaries through collective sales of farm output, thus increasing farm income. This will encourage farmer's investment in non-traditional soil conservation technologies.

The use of demonstration plots will reduce risk aversion of farmers and thus increase their probability of adoption of the sustainable; non-traditional soil conservation technologies.

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